# SOLID WASTE GUIDELINE # 20

# "Fate and Transport Modeling for Solid Waste Disposal Facilities"

## 1.0 Introduction

The purpose of this document is to provide guidance for collecting, analyzing, and submitting to the Department of Environmental Quality (Department) Solid and Hazardous Waste Division (SHWD) the information that is necessary for fate and transport modeling. This information will be used by the Department and applicants to evaluate performance based designs (PBDs) for municipal solid waste (MSW) landfills. To clarify, the term "fate" refers to the effect of chemical and biological processes that affect the ultimate form of a given contaminant during migration. The term "transport" refers to physical processes that govern the rate and extent of contaminant migration.

For purposes of this guidance, a performance based design is one that does not include a composite liner and leachate collection system (hereinafter referred to as an engineered containment system (ECS)) as defined by the Wyoming Solid Waste Rules and Regulations (SWRR). A composite liner is a system consisting of two components; the upper component must consist of a minimum 30-mil flexible membrane liner (FML) and the lower component must consist of at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than $1 \times 10^{-7}$ cm/sec.

The information needed to support a proposed PBD must be submitted as supporting documentation in the permit application for a new MSW landfill or lateral expansions at existing MSW landfills. This process may also be useful as a screening tool to evaluate PBDs at prospective sites before permit applications are prepared and submitted. The Department stresses that fate and transport modeling is only one component of a complete application for a PBD, and that the final decision on the acceptability of a proposed PBD will not be based solely on the results of fate and transport modeling. Certain site specific conditions, such as fracturing, or, rarely in Wyoming, karst conditions, may preclude the use of modeling.

The information in this document should not be interpreted by applicants or Solid and Hazardous Waste Division (SHWD) staff as mandatory. Proposals for alternate approaches will be considered by the SHWD on a case-by-case basis. While focused on MSW landfills due to regulatory requirements, the concepts presented in this guideline may also be useful to owners and operators of construction/demolition landfills, and industrial landfills.

## 2.0 Background

Chapter 2, Section 4(j) of the Wyoming Solid Waste Rules and Regulations (SWRR) requires that permit applications for new units and lateral expansions at municipal solid waste landfills must contain either a composite liner and leachate collection system, or a PBD. To allow consideration of alternative approaches, site-specific conditions and changing technologies, the SWRR above do not contain prescriptive information regarding how an operator must demonstrate that PBD requirements are met.

Guidelines have been prepared to outline an approach that consists of:

- Evaluating site specific geologic and hydrogeologic information;
- Evaluating leachate generation rates using the HELP model and local climate data; and
- Using contaminant fate and transport modeling to evaluate migration of contaminants to groundwater.

## 3.0 Model selection and site-specific data collection

Several general criteria should be considered when evaluating potential models, including, but not limited to the following:

- Model selection must be based on the model's ability to represent the specific physical and chemical processes of interest at the site;
- The model must be technically sound and legally defensible;
- The model must have adequate technical documentation;
- The model must have undergone independent professional peer-review, validation studies, and sensitivity testing;
- The model's simplifying assumptions must be well-documented, justifiable, and appropriate for the specific application proposed; and
- Adequate training of the model user and experience with the proposed model is necessary.

Applicants may wish to use a tiered approach to modeling, using relatively simple models and default parameters to screen a site, and then advance to a more sophisticated model with site-specific data for a more detailed analysis. If needed, the following default values may be used for screening level evaluations; however, site-specific data needs to be used for final evaluations:

- $f_{oc}$ (fraction organic carbon in soil) (g/g) = 0.001
- Dry bulk density (g/cc) = 1.5
- Soil particle density (g/cc) = 2.65
- Water-filled soil porosity ($ml_{water}/cc_{soil}$ )= 0.3
- Soil porosity ($cc_{pore}/cc_{soil}$ ) = 0.434
- Air-filled soil porosity ( $cc_{air}/cc_{soil}$) = 0.134

The default values above are the same as those used in the Department's Voluntary Remediation Program, and may be found in the Soil Screening Guidance, EPA (1996).

Sampling techniques typically used for collection of soil samples for chemical analyses are

generally not adequate for obtaining samples for geotechnical analysis (ASTM, 1999). Applicants must be sure that appropriate sampling techniques are applied for collection of representative samples for the desired analysis. As noted by ASTM (1999), care must be taken when adopting literature values for use alone or in combination with site-specific measured values, as model input parameters.

The soil to groundwater transport pathway is of primary interest for purposes of evaluating proposed PBDs related to the fate and transport of contaminants from an unlined landfill. ASTM guidance (ASTM, 1999) indicates that, for the soil to groundwater transport pathway, the following parameters tend to be sensitive parameters from a model input perspective:

- Source concentration;
- Total soil porosity;
- Fraction of organic carbon;
- Carbon-water sorption coefficient; and
- Soil-water sorption coefficient.

This information may be used by applicants in order to focus expenditure of funds on the most sensitive model input parameters. Because every model will have variations in input parameter sensitivity, applicants need to evaluate the specific model(s) they intend to use to identify model-specific sensitivity of the input parameters.

## 4.0 Reporting

A thorough, detailed, and comprehensive report of any and all modeling efforts must be presented as supporting documentation. This report must include:

- The name, version and date of the model used
- A list of all assumptions used in the model and justification for their use
- A list of all input data required by the model, including justification for any manipulation of input data. All site specific data must be clearly identified
- Information on model calibration and validation
- Results of sensitivity and uncertainty analysis

In all cases, supporting documentation needs to be provided as an exhibit or appendix and be properly referenced in the narrative.

## 5.0 Professional Geologist Certification

Geological services or work must be stamped, signed, and dated by a professional geologist (see W.S. § 33-41-115).

## 6.0 Additional Information

Further information or clarification can be obtained from the following Solid and Hazardous Waste Division offices. Comments and suggestions for improvements are always appreciated.

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| Casper: | (307) 473-3450 |
| Cheyenne: | (307) 777-7752 |
| Lander: | (307) 332-6924 |

## 7.0 References

Individuals desiring additional information may wish to consult additional resources listed below. Ideas and concepts in some of the references listed below were considered during development of this document.


Bonaparte, R., 1995, Long-Term Performance of Landfills, in: GEOENVIRONMENT 2000, edited by Y.B. Acar and D.E. Daniel, ASCE Special Publication No. 46, p. 514-553.

EPA Center for Subsurface Modeling Support (CSMoS) available on line: http://www.epa.gov/ada/csmos/

ASTM, 1999, RBCA Fate and Transport Models: Compendium and Selection Guidance, available on line: http://www.epa.gov/oust/rbdm

Rooker, A.P., 2000, A Critical Evaluation of Factors Required to Terminate the Post-Closure Monitoring Period at Solid Waste landfills, Master of Science Thesis, North Carolina State University, Department of Civil Engineering.

U.S. EPA, December 2002, Assessment and Recommendations for Improving Performance of Waste Containment Systems, EPA/600/R-02/099, available on line: http://pbadupws.nrc.gov/docs/ML1217/ML12179A248.pdf

U. S. EPA, April 1996, Soil Screening Guidance: User's Guide. EPA/540/R-60/018.

U. S. EPA, April 1992, Groundwater Issue - Fundamentals of Ground-Water Modeling, OSWER, EPA/540/S-92/005, 11p.

## 8.0 Guideline Approval

I have reviewed and approved the policies and procedures described in this guidance document.

Signed

Alan Edwards Dec. 24, 2013

Alan Edwards — Date
Acting Administrator
Solid and Hazardous Waste Division

### Guideline History

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| August 22, 2002 | Workgroup Draft Version 1 - DO NOT CITE |
| June 6, 2003 | Workgroup Draft Version 2 - DO NOT CITE |
| June 23, 2009 | Final Version |
| September 26, 2013 | Revised |